

What is Claimed is:

1. A quantum well infrared photodetector (QWIP) comprising:

a plurality of photodetectors, each having a barrier layer and a well layer, each well layer of each photodetector coupled between two barrier layers, each well having a well bottom, and a well top, and each well supporting bound energy states therein;

materials and thicknesses of said photodetector element being selected such that a bound excited state energy is substantially resonant with said well top; and

said photodetectors including a first group and a second group wherein the materials, thicknesses and dimensions of said wells and barriers are selected such that the peak intersubband absorption is at a first wavelength of electromagnetic radiation for the first group and the peak intersubband absorption is at a second wavelength for the second group.

2. A QWIP as in claim 1 wherein said wells in said first group are formed of a different material than said wells in the second group.

3. A QWIP as in claim 2 wherein said first group and said second group of photodetectors are separated by an intermediate layer.

4. A QWIP as in claim 3 wherein said wells in the first group are formed of GaAs, said wells in the second group are formed of  $\text{In}_x\text{Ga}_{1-x}\text{As}$  and said barriers in both groups are formed of  $\text{Al}_x\text{Ga}_{1-x}\text{As}$ .

5. A QWIP as in claim 3 comprising:  
a plurality of photodetectors in the first group arranged in a first stack and  
a plurality of the photodetectors in the second group arranged in a second stack, the first stack being disposed adjacent to the second stack, the first and second stacks being a double stack.

6. A QWIP as in claim 5 wherein a plurality of said double stacks are arranged in an array having rows and columns.

7. A QWIP as in claim 6 wherein all of the photodetectors in the first group in alternate rows are shorted, rendering them inoperative.

8. A QWIP as in claim 7 wherein all of the photodetectors in the second group in alternate rows are shorted, rendering them inoperative.

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9. The QWIP as in claim 8 further comprising a multiplexer coupled to said photodetector in said array and generating a stream of data from the first group of photodetectors followed by a stream of data selectively from the first and second groups of photodetectors, whereby separate images of the first and second wavelength can be formed from said data.

10. The QWIP as in claim 1 wherein said each photodetector in the first group is adjacent to a photodetector in the second group.

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11. A QWIP as in claim 10 further comprising a continuum transport band, carrying a photocurrent from said wells, wherein the continuum transport band has a smooth energy level profile between wells in the first and second groups of photodetectors.

12. A QWIP as in claim 11 wherein said barriers in the second group have a barrier height equal to that of the barriers in the first group.

13. A QWIP as in claim 12 wherein the photodetectors in the first group and in the second group have barriers formed of a material including aluminum, wherein the aluminum mole ratio is the same for the barriers in both groups.

14. A photodetector as in claim 1 further comprising first and second gratings facing the first and second groups of photodetectors, respectively, such that the first gratings transmit primarily the first wavelength and the second grating transmits primarily the second wavelength of electromagnetic radiation.

15. A QWIP as in claim 10 wherein said barrier layers are made of  $\text{Al}_x\text{Ga}_{1-x}\text{As}$  and said second group of wells are formed of  $\text{Al}_y\text{Ga}_{1-y}\text{As}$  where  $x$  is not equal to  $y$ .

16. A photodetector as in claim 15 wherein said first and second groups of photodetectors and said first and second gratings are arranged in an array.

17. A quantum well infrared photodetector comprising:  
a plurality of photodetectors each having a barrier layer  
and well layer, each well layer of each photodetector coupled  
between two barrier layers, each well having a well bottom,  
and a well top, and each well supporting bound energy states  
therein;

each well having an excited state energy level and a  
thermionic emission energy level and wherein said excited  
state energy level is approximately equal to the thermionic  
energy level, whereby the wells exhibit intersubband  
absorption; and

said photodetectors including a first and a second group  
of photodetectors, wherein the wells are configured such that  
said excited state energy level for the wells in the first  
group is different from the excited state energy level of the  
wells in the second group.

18. A QWIP as in claim 17 further comprising a continuum  
energy level between adjacent wells and carrying excited  
charge carriers, wherein said excited energy state is at a  
position such that the excited carriers can escape into the  
continuum by tunneling through less than 50 Å of material.

19. A QWIP as in claim 17 wherein the photodetectors in the first group transition to an excited state in response to infrared radiation of a first wavelength and photodetectors in the second group transition to an excited state in response to infrared radiation of a second wavelength.

20. A QWIP as in claim 19 wherein the first wavelength is mid-wavelength infrared radiation and the second wavelength is long wavelength infrared radiation.

21. QWIP as in claim 17 wherein said wells in said first group are formed of a different material than said wells in the second group.

22. A QWIP as in claim 17 further comprising a continuum transport band, carrying a photocurrent from said wells wherein the continuum transport band has a smooth energy level profile between wells in the first and second groups of photodetectors.

23. A QWIP as in claim 22 wherein the heights of the energy levels in said barriers from the first and second groups of photodetectors are the same.

24. A QWIP as in claim 17 wherein said barriers in the first and second groups of photodetectors are formed of the same material.

25. A QWIP as in claim 17 comprising:

a plurality of photodetectors in the first group arranged in a first stack and

a plurality of the photodetectors in the second group arranged in a second stack, the first stack being disposed adjacent to the second stack, the first and second stacks being a double stack.

26. A QWIP as in claim 25 wherein a plurality of said double stacks are arranged in an array having rows and columns.

27. A QWIP as in claim 26 wherein all of the photodetectors in the first group in alternate rows are shorted, rendering them inoperative.

28. A QWIP as in claim 27 wherein all of the photodetectors in the second group in alternate rows are shorted, rendering them inoperative.

29. The QWIP as in claim 17 wherein said each photodetector in the first group is adjacent to a photodetector in the second group.

30. The QWIP as in claim 17 further comprising a continuum transport band, carrying a photocurrent from said wells, wherein the continuum transport band has a smooth energy level profile between wells in the first and second groups of photodetectors.

31. A QWIP as in claim 24 further comprising a pair of contacts, one connected to the first stack and one connected to the second stack.

32. A QWIP as in claim 30 wherein said first stack protrudes from a side of said double stack wherein one of said contacts is connected to said first stack at the top of said protruding first stack.



33. A quantum well infrared photodetector focal plane array, comprising:

a radiation detecting surface;

5 first and second photodetector elements each having a plurality of periods, each period having a barrier layer of a first semi-conductor material and a well layer of a second semi-conductor material, said first and second materials defining a band gap therebetween, each well layer of each period coupled between two barrier layers, each well having a well bottom, and a well top and each well supporting an unexcited energy state for photocarriers, and a bound-excited energy state for photocarriers, said photocarriers excited by radiation into said bound excited energy states;

10 materials and thicknesses of said periods of said first and second photodetector elements being selected such that a bound energy state is substantially resonant with said well top and such that the peak intersubband absorption wavelengths of the first and second photodetector elements are different;

15 a plurality of the first and second periods of photodetector elements arranged with one stacked on top of the other forming a plurality of double stacks, wherein a plurality of said double stacks are arranged in rows in an array;

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said first photodetector elements in a first group of rows being inoperative and said second photodetector elements in a second group of rows being inoperative; and a multiplexer generating a stream of data from the first group of rows followed by a stream of data from the second group of rows.

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